Coordinated with the Quality Assurance Office

Minutes № 7, September 15, 2023year

Vice-rector /Associate Professor Nino Jojua/

Reviewed at the School Board

Minutes №32, September 18, 2023 year

Dean of the School / Prof. Tea Todua/

Approved by the Governing Board

Minutes №18, September 25, 2023 year

Rector / Saffet Bayraktutan /

Doctorate Educational Program

**Computer Science**

**(English)**

Tbilisi

2023 year

**Name of the Educational Programme:** Computer Science /კომპიუტერული მეცნიერება

**School:** Computer Science and Architecture

**Programme Coordinator(s):** Tea Todua, Professor, Candidate of Technical Sciences. Tel.: +995 593 165999. E-mail: ttodua@ibsu.edu.ge

**Education Cycle and Level of the qualification:** Doctorate (The third cycle of Higher Education) Level 8 of the NQF

**Type of the Educational Programme:** Academic / Major

**Detailed Field and Code (ISCED – F – 2013):** Information and Communication Technologies 06, Computer Sciences 0613

**Awarded Qualification:** Doctor of Computer Science/კომპიუტერული მეცნიერების დოქტორი

**Code of Qualification:** 0613

**Language of Education:** English

**Credit Value of the Programme:** 60 credit ECTS (study components)

**Structure of the Programme:** The University uses the European Credit Transfer System (ECTS): 1 credit = 25 hours, which covers both, contact and student independent working hours. The duration of the educational program is not less than 3 years, program includes 60 credits of study components and research components (dissertation). The program includes: Mandatory courses 30 credits and elective courses 30 credits (10 courses are offered as elective courses, each has 10 credits – totally 100 credits);

**Program Admission Precondition:** According to Georgian legislation, the candidate to enroll at this program should have a Master’s degree in computer science or closely related fields. According to the university regulations, the candidate should have at least the B2 level in English certified by an international certificate and the relevance is approved by the IBSU School of Languages or a Master’s diploma received from English language program during last five years. In addition, according to the university regulations, the candidate has to submit a dissertation (research) proposal. The correspondence of the proposal to the program requirements is assessed by the Dissertation Field Board commission according to the rubric below, afterwards the interview based on the proposal is held.

The assessment criteria for the dissertation proposal are:

| **CRITERIA** |  **Not reflected** | **Unacceptable** | **Acceptable** (with major changes) | **Acceptable** (with minor changes) | **Acceptable** |
| --- | --- | --- | --- | --- | --- |
| 0 | 1-3 | 4-6 | 7-9 | 10-12 |
| **Title**: neither too narrow, nor too wide; terms used adequately; sounds contemporary |  |  |  |  |  |
| **Significance and novelty**: the topic is contemporary, less studied; the potential of novelty and value is presented |  |  |  |  |  |
| **Theoretical  and practical value**: it is presented how the research can impact the field |  |  |  |  |  |
| **Literature overview**: presents main achievements and names; reference list includes at least 10 important titles |  |  |  |  |  |
| **Research questions / hypothesis**are original and well-formulated |  |  |  |  |  |
| **Research methods** are adequate to the topic and well defined |  |  |  |  |  |
| **Academic and clear language** |  |  |  |  |  |
| Sub-totals: |  |  |  |  |  |
| Total:  |  |

Requirement for the next step:

A candidate who obtained at least 51 points (out of 84) is admitted to the interview/oral presentation. The proposal of a candidate, who obtained 41-50 points, will be reassessed if the candidate improves the proposal within the submission deadline.

| **Interview / oral presentation:** reveals a good knowledge of the topic,arguments any point from the proposal | **Not reflected** | **Unacceptable** | **Acceptable** (with major changes) |  **Acceptable** (with minor changes) | **Acceptable** |
| --- | --- | --- | --- | --- | --- |
| 0 | 1-4 | 5-8 | 9-12 | 13-16 |
|  |  |  |  |  |

The candidate who obtained at least 9 from the interview / oral presentation will be considered as ‘passed’.

**Purpose of the Programme**:

The goals of the PhD Program in Computer Science are:

1. Preparation of highly qualified personnel for academic and scientific careers in the field of computer science. The faculty has three directions of computer science: theoretical computer science, system design and security, artificial intelligence. The doctoral program is designed to take into account the interests of individual students, which means that students must make a distinct and important contribution to the study and development of at least one direction while studying for a doctorate.
2. To prepare computer science PhD students for industry, which means that PhD students will develop the ability to formulate, model, analyze, solve and implement complex problems coming from the industry.
3. To develop PhD students the skills necessary for a successful career in the market, to make it focused on finding ways to solve interdisciplinary scientific problems, to improve the vision of professional and ethical responsibility for academic, scientific and industrial work.

**Learning Outcome**:After completing the PhD Program of Computer Science, the graduate will have the following competencies necessary for his / her specialization.

1. Graduates demonstrate a systematic understanding of the field of computer science.
2. Graduates have a deep understanding in the three major areas of computer science: theoretical computer science, systems design and security, artificial intelligence.
3. Graduates have a knowledge to evaluate critically a solution to a complex research level problem, and propose possible improvements.
4. Graduates know how to prepare project proposals, how to write obtained scientific results and make presentation.
5. Graduates know how to use computer systems, how to develop software, and how to model real-world problems.
6. Graduates are able to carry out scientific research, review scientific papers and dissertations, and publish an article describing scientific results in a highly ranked refereed journal and conference materials.
7. Graduates can occupy academic positions at the university, deliver lectures in various fields of computer science, and supervise undergraduate, graduate, and doctoral studies.
8. Graduates are aware of the potential ethical and social implications of research, peer review, technology development, and application.
9. Graduates are professionals in the field of computer science, they are aware of the achievements in the field and consider their work as an integral part of this field.

**Program goals and learning outcomes map:**

| **Program goals** | learning outcome 1 | learning outcome 2 | learning outcome 3 | learning outcome 4 | learning outcome 5 | learning outcome 6 | learning outcome 7 | learning outcome 8 | learning outcome 9 |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **(1)** |  |  |  |  |  |  |  |  |  |
| **(2)** |  |  |  |  |  |  |  |  |  |
| **(3)** |  |  |  |  |  |  |  |  |  |

**Learning Outcome Map:**

| **Course / Module / Internship / Research Component** | **Criteria of Competencies** |
| --- | --- |
| **LO 1** | **LO 2** | **LO 3** | **LO 4** | **LO 5** | **LO 6** | **LO 7** | **LO 8** | **LO 9** |
| **Pedagogy of Higher Education** |  |  |  |  |  |  | **3** |  |  |
| **Research Methodology** | **2** | **2** | **2** | **3** |  | **3** | **1** | **3** | **2** |
| **PhD Seminar I** | **2** | **2** | **1** | **2** | **1** | **2** | **1** | **2** | **2** |
| **PhD Seminar II** | **2** | **2** | **1** | **2** | **1** | **2** | **1** | **2** | **2** |
| **Professor's Assistantship** | **2** | **2** | **2** | **2** | **2** | **2** | **3** | **2** | **2** |
| **PhD Thesis** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** |

**Methods of Attainment of Learning Outcomes**:Study components considered by the program are carried out using following teaching and learning methods:

**Lecture** – Lectures involve discussion of major theoretical material, concepts, terms, etc. through ensuring students’ active involvement. It is basically oriented on thorough teaching scientific theories and approaches of study material. During lectures, subject related issues are deeply explained, students are actively involved in the discussions and clear perception and comprehension of topics using brain-storming and other interactive methods.

**Group work** – Group work develops the knowledge and skills of planning and fulfillment of specific tasks under cooperative environment. Group work includes discussion of case studies, quizzes, practical assignments, different examples, through which students obtain skills of problem resolution in teams that in turn ensures development of team working skills and the possession of competencies of considering and accepting others opinion.

**Practice / lab work** – In order to ensure deep understanding and perception of the issues, practice/lab work concentrates on accurate discussion of relevant examples, cases, video materials, exercises and the ways of their resolution, which ensures the formation of students’ ability to use the obtained theoretical knowledge in practice and develop analytic and creative thinking.

**Seminar** – The aim of seminars is to create the context for students which enables them to get the details, and better understand and realize the issues and topics discussed during lectures. Seminar is the means of knowledge transfer, involves discussion and drawing conclusions, and it is coordinated by a lecturer with certain specific objectives. Seminars are conducted in accordance to specific aims and are in line with the material covered throughout lecturers.

**Individual work** – Through individual work students deepen and internalize the knowledge obtained throughout the lecturers. Individual work involves searching for the materials through course-books or other sources of information, realizing and learning the obtained information; it also involves completing home-tasks. All these activities deepen the interest in certain issues, the wish to study these issues individually, they help students develop the ability of thinking individually, analyze the obtained information and draw conclusions.

**The learning and teaching methods are implemented using the following activities:**

**Presentation (by lecturer)** – The method consists of narration and speaking through which the information is provided by a teacher to a learner. Through this process teacher transfers knowledge verbally, explains the material and students obtain this knowledge through listening, memorizing and comprehension. It is important to make sure that understanding occurs and information is perceived correctly. In case of necessity additional instruction should be provided. A teacher is giving specific examples and provides detailed explanation.

**Demonstration** - It demonstrates information visually. It’s sufficiently effective when reaching the result because it takes into consideration the interests of different students. Learning material can be demonstrated by lecturer or student. This method helps different steps of learning process to be seen visually and concretize, what should student do independently. At the same time, this strategy visually demonstrates the main point of the subject/problem.

**Induction** – modern, one of the most effective student-oriented methods. Major objective of this method is to collect much data and by generalizing the observed perspectives discover general principles through which it is possible to discuss the facts, cases and events and explain them. Learning is oriented at relying on facts and developing rules through generalizing these facts, thus, moving from specific facts to general rules.

**Deduction** – a traditional method of teaching and learning which sees a teacher as a major source of information and students learn general theories through a teacher’s supervision. Deductive method of learning determines that kind of any subject knowledge, which presents the process when depending on general knowledge we discover new knowledge, so the process goes from general to concrete.

**Analysis** – In the modern world majority of disciplines have become complex; accordingly, courses in these fields require complex approaches. The method of analysis helps us to dismantle multi-disciplinary and inter-disciplinary courses into parts which allows dividing an issue under the study into separate aspects. This helps to discuss separate issues in details.

**Synthesis** - Method of synthesis means back-procedure, using some parts and making the whole with them. This method helps to see the whole problem.

**Case Study** – active problem-situation analysis method, which presupposes discussing real cases and discussing them which allows students to look at the issues from different perspectives, analyze possible solutions of the problem and choose and justify specific strategies, objectives and expected outcomes. A case presents a context and it is an instrument by itself which allows a student to use specific knowledge obtained through the course and put it into practice in the context which is close to real-life situation.

**Brain Storming -** collecting as many/various ideas about the topic/issue as possible. The method enhances development of creative approach towards the problem. It supports the development of creative approaches when students try to see an issue from different perspectives. This approach ensures that every person is involved in the learning process. It is efficient for a large group and is used in stages**.**

**Discussion / Debates –** one of the most broadly spread interactive methods; discussion raises the level of student involvement; while discussion different opinions are confronted and the discussion is not limited to the questions asked by a teacher. Overall aim is to synthesis different views. This method develops students’ ability of reflection and argumentation.

**Simulation, Role Plays and Situational Games** – belong to game-type of methods which consist of simulation (role-play) games, didactic or educational games, situational games, game-like approaches and procedures. Games developed through pre-developed scenarios enable students to look at important issues from different perspectives. They help students to form alternative viewpoints. Like discussion, these games develop students’ ability to express their own opinion independently and defend their attitudes in a dispute.

**Project** – This approach is a unity of perceptive methods, which makes it possible to solve a problem through students’ independent work and presenting the achieved solutions. This approach raises students’ motivation and responsibility; working on the project involves planning, research, practical activities and presenting the results; the projects are complete if the outcomes are presented in a convincable manner through examplifying specific results; a project could be done individually, in peer or group work; upon completion, the project is presented to a broader audience.

**Presentation (by student/students)** – Taking into consideration the development of technology presentation is one of the most interactive and effective ways of teaching. It is a combination of teaching and learning methods which allows a student to solve a problem through independent work and presenting the outcomes. This method raises students’ motivation to work independently; it also develops specific skills – planning, researching, and presenting data in an effective manner; it develops skills to work in groups or individually.

**Teaching though Electronic Sources** – The method implies teaching through internet and the means of multimedia. It consists of all the components of teaching process that are realized through specific means of internet and multimedia.

**Task Solving** – Gradual mastering of theoretical material through solution of specific tasks that ensures development of skills of using theoretical knowledge independently. While solving the tasks the lecturer pays attention to the methods of task solution and to the relevant use of the various schemes or chart drawing techniques or to the techniques of task solution;

**Problem Solving** – The method of teaching that enables employment of newly obtained knowledge by students through study, analysis and solution of specific problem. While employing this method it is important to assess and analyze the results received through the solution of a specific problem. By using this method the skills and the ability of a student to use obtained knowledge in practice is developed.

**Group Work** – Teaching method through which students are divided into the groups and the assignments are given to each of the groups. Group members process the information individually and share their ideas to other group members at the same time. Group members may be assigned different functions depending on the objective defined by the task. This method ensures active involvement of each student in the process of teaching.

**Individual Work** – The method when a student individually performs the tasks and the assignments determined through the academic process.

**Working with a Course-Book** – Actively used method in a process of learning through which a student process given material by using given literature and other sources.

**Doing Homework** – Independent work when students do the home assignments determined through the academic process. Doing home assignments implies reading, processing and studying material determined through the study course as well as doing given assignments in written form or presenting them orally.

**Student Knowledge Evaluation System**:

The goal of evaluation is to determine student’s education results qualitatively in relation to academic program goals and parameters.

Student may be assessed orally and/or in a written way. A student’s knowledge and skills are assessed through 100 points grading system. It consists of midterm and final evaluations, sum of which makes up 100 points.

The Grading system allows:

five types of positive grades:

* 1. (A) Excellent – 91-100 points;
	2. (B)Very good – 81-90 points;
	3. (C) Good - 71-80 points;
	4. (D) Satisfactory - 61-70 points;
	5. (E) Enough - 51-60 points;

two types of negative grades:

1. (FX) Fail – 41-50 points, meaning that a student requires some more work before passing and is given a chance to sit an additional examination after independent work;
2. (F) Fail – 40 points and less, meaning that the work of a student isn’t acceptable and he/she has to study the subject anew.

For the midterm and final evaluations minimal passing grade is set. The final evaluation minimal passing grade must not exceed 60% of final evaluation grade.

Midterm and final evaluation grade distribution, their minimal competence levels and assessment criteria are described in the corresponding syllabus.

A credit can be awarded only after the attainment of learning outcomes, envisaged by the course syllabus and following requirements (both have to be fulfilled):

1. Obtaining minimal competence levels set for midterm and final evaluations;
2. Obtaining minimum 51 points out of 100 points of final grade.

 A student is allowed to take an additional (make-up) exam in case he/she scored 41-50 points of final grade or minimum 51 points, but did not obtain minimal competence level set for final evaluation.

The format and evaluation criteria of the midterm and final evaluation components are determined according to the syllabus of each study course, taking into account their specificities and following the above criteria.

The assessment of the scientific-research component is carried out as a whole, in the form of a final assessment. This includes the formative evaluation stage (evaluation of experts and presentation to the pre-defense) and the evaluation received at the defense.

The prerequisite for awarding the academic degree of doctor is to pass the formative evaluation stage and the average of the points assigned by the Defense Commission, not less than 51 points.

During the **defense** of the doctoral dissertation, the assessment takes place according to the following rubric:

|  | **Criteria** | **Maximum points** | **Actually awarded points** |
| --- | --- | --- | --- |
| 1 | Significance | 10 |  |
| 2 | Practical value of research | 10 |  |
| 3 | Theoretical value of research | 10 |  |
| 4 | Novelty | 10 |  |
| 5 | Depth of the analysis of the topic and originality of conclusions | 15 |  |
| 6 | Reliability of results (statistical treatment of experiment, logical argumentation) | 5 |  |
| 7 | During the defense: presentation (logical argumentation, structure of the presentation, clear speech, presenting the basic ideas of the dissertation) | 15 |  |
| 8 | During the defense adequately answering the questions, defending one’s viewpoint, using terminology appropriately | 15 |  |
| 9 | During the presentation efficiently using the visual aids | 10 |  |
|  |
| **Total** | 100 | defended / did not defend |

Assessment criteria # 1-6 is done according to dissertation and publications.

The assessment of dissertation finally is done with the following wording:

a)      Excellent (summa cum laude) –  91points and above – an excellent work;

b)      Very good (magna cum laude) – 81-90 points– a result that exceeds the requirements in every way;

c)      Good (cum laude) – 71-80 points – a result that exceeds the requirements;

d)      Medium (bene) – 61-70 points – an average level work that meets the basic requirements;

e)      Satisfactory (rite) – 51-60 points – result, which despite its shortcomings, still meets the requirements;

f)       Insufficient – 41-50 points –  unsatisfactory level of work that does not meet the requirements;

g)      Completely unsatisfactory (sub omni canone) – 40 points and less – result that meets none of the requirements.

The student is awarded the academic degree of doctor in case of obtaining any of the above mentioned grades considered by items from a) to e); in case of getting the grade considered by item f) – the student has a right to present the rewritten doctorate dissertation during the first year; and in case of getting the grade considered by item g) – the student has no right to present the same doctorate dissertation.

**Specificities of the Organization of the Teaching Process:**

The PhD program is normally continues not less than three years and combines study and research components. During first year, students are expected to complete study component, which means they have to collect 60 ECTS credits from courses offered by the curriculum.

According to curriculum students are supposed to collect 30 ECTS from mandatory courses and 30 ECTS from elective courses. Elective courses are distributed as follows:

* Theoretical computer science courses: discrete optimization algorithms, rewriting theory, automated reasoning;
* System design and security courses: cyber physical systems, access control models, blockchain and cybersecurity.
* Artificial intelligence courses: computational thinking for modeling and simulation, internet of things (IoT), wavelets theory, pattern recognition applications.

After completion of the study component, students will have to work on their PhD research.

To be admitted to the PhD defense the following requirements should be fulfilled:

1. Students should publish (accepted for publication) at least one paper dealing with dissertation results in a journal indexed by Clarivate Analytics databases or in a conference proceeding indexed by CORE.
2. The PhD thesis should be reviewed by two international field experts (researchers with a doctoral degree who works in a foreign educational or scientific organization) and both reviews has to be positive.

**Field of Employment:**

The PhD program in Computer Science will prepare internationally qualified competitive professionals. The knowledge and skills acquired by graduates will enable them to meet the challenges of modern scientific achievements. Graduates will be able to be employed in both private and public sectors, as a leading specialist, where they will practically perform the main professional activities both independently and in a group. In particular, they can occupy a scientist position at research unit, an academic position at educational organization and a leading specialist position at IT department in an industry.

**Information Concerning Material Resources Necessary for the Implementation of the programme:**

Information Concerning Material Resources Necessary for the Implementation of the programme: International Black Sea University is fully equipped with all the necessary material resources aimed to fulfil the educational program successfully:

* Classrooms equipped with different educational facilities;
* Computer laboratories with full internet access;
* University library equipped with modern technologies, internet, and rich paper and electronic books;
* Corresponding resources to the course relevant topics available through the electronic database of the university (through Smart portal);
* Other material resources owned by the university.
* Compulsory literature indicated in syllabuses is available in the university’s library. Also via an electronic library; IBSU is a registered member of the following e-libraries. IBSU is officially involved in the ELSEVIER international scientific system. IBSU staff and students are able to have an access to the Elsevier databases such as Scopus; Science Direct; Scival Funding (Funding Institutional)

<https://www.ebsco.com/>

[https://www.elsevier](https://www.elsevier.com/solutions/scopus)

<http://polpred.com/>

[www.journals.cambridge.org](http://www.journals.cambridge.org/)

<https://home.heinonline.org/>

[www.opendoar.org](http://www.opendoar.org/)

[www.roar.eprints.org](http://www.roar.eprints.org/)

[www.doaj.org](http://www.doaj.org/)

[www.beallslist.weebly.com](http://www.beallslist.weebly.com/)

[www.gutenberg.org](http://www.gutenberg.org/)

[www.memory.loc.gov](http://www.memory.loc.gov/)

[www.wdl.org](http://www.wdl.org/)

[www.obiblio.sourceforge.net](http://www.obiblio.sourceforge.net/)

* In addition, the university has all the means for extracurricular activities for students (sports, creativity, social activities).

**Information Concerning Human Resources Necessary for the Implementation of the programme:**

| **№** | **Name, Last name** | **Academic degree** | **Position** |
| --- | --- | --- | --- |
| 1. | Michał Małafiejski | Doctor of Computer Science (Habilitation) | Affiliated Professor |
| 2. | Natela Doghonadze | Doctor of Science degree in Methods of Teaching | Affiliated Professor |
| 3. | Vakhtang Rodonaia | PhD degree in Engineering of Informatics (Equivalent to PhD) | Affiliated Associate Professor |
| 4. | Khatuna Elbakidze | Candidate of physics and mathematics Sciences (Equivalent to PhD) | Invited Lecturer |
| 5 | Tea Todua | Candidate of Technical Sciences | Professor |
| 6. | Mikheil Rukhaia | Doctor of Technical Sciences | Associate Professor |
| 7. | Mariam Dedabrishvili | Doctor of Engineering in Informatics (Equivalent to PhD) | Affiliated Assistant Professor |
| 8. | Giorgi Ghlonti | Candidate of Technical Sciences (Equivalent to PhD) | Affiliated Professor |
| 9 | Irakli Rodonaia | PhD (Doctor of Philosophy) in Technology, Candidate of Technical Sciences | Affiliated Professor |
| 10 | Giorgi Baghaturia | PhD degree in Mathematics | Invited Lecturer |

**Study Plan**

| **#** | **Course / Module / Internship / Research Component** | **Status** | **Credit number** | **Distribution of credits per courses and semesters** |  |  | **Distribution of hours** | **Number of contact hours per week** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **I s.y.** | **II s.y.** | **III s.y.** | **IV s.y.**  |  | **Contact hours** | **Independent work** | **Total number of hours** |
| **I Semester** | **II Semester** | **III Semester** | **IV Semester** | **V Semester** | **VI Semester** | **VII Semester** | **VIII Semester** | **Lecture / Consultation** | **Seminar / Group Work / Practical work** | **Midterm exam** | **Final exam** | **Total number of contact hours** |
| 1 | Pedagogy of Higher Education | Mandatory | **5** | **5** |  |  |  |  |  |  |  | 8 | 20 | 2 | 2 | 32 | 93 | 125 | 2 |
| 2 | Research Methodology | Mandatory | 10 | 10 |  |  |  |  |  |  |  | 15 | 13 | 2 | 2 | 32 | 218 | 250 | 2 |
| **3** | PhD Seminar I | Mandatory | **5** | **5** |  |  |  |  |  |  |  | 0 | 15 | 0 | 0 | 15 | 110 | 125 | 1 |
| 4 | PhD Seminar II | Mandatory | **5** |  | **5** |  |  |  |  |  |  | 0 | 15 | 0 | 0 | 15 | 110 | 125 | 1 |
| 5 | Professor's Assistantship | Mandatory | **5** |  | **5** |  |  |  |  |  |  | 30 | 0 | 0 | 2 | 32 | 93 | 125 | 2 |
| 6 | PhD Thesis | Mandatory |  |  |  |  |  |  |  |  |  | 120 |  |  |  | 120 | 2880 | 3000 | 2 |
| 7 | Cyber Physical Systems | Elective | 10 | 10 |  |  |  |  |  |  |  | 28 | 14 | 2 | 2 | 46 | 204 | 250 | 3 |
| 8 | Wavelets Theory | Elective | 10 | 10 |  |  |  |  |  |  |  | 30 | 12 | 2 | 2 | 46 | 204 | 250 | 3 |
| 9 | Computational Thinking for Modeling and Simulation | Elective | 10 | 10 |  |  |  |  |  |  |  | 16 | 26 | 2 | 2 | 46 | 204 | 250 | 3 |
| 10 | Automated Reasoning | Elective | 10 | 10 |  |  |  |  |  |  |  | 28 | 14 | 2 | 2 | 46 | 204 | 250 | 3 |
| 11 | Internet of Things (IoT) | Elective | 10 | 10 |  |  |  |  |  |  |  | 24 | 18 | 2 | 2 | 46 | 204 | 250 | 3 |
| 12 | Access Control Models | Elective | 10 |  | 10 |  |  |  |  |  |  | 28 | 14 | 2 | 2 | 46 | 204 | 250 | 3 |
| 13 | Blockchain and Cybersecurity | Elective | 10 |  | 10 |  |  |  |  |  |  | 28 | 14 | 2 | 2 | 46 | 204 | 250 | 3 |
| 14 | Discrete Optimization Algorithms | Elective | 10 |  | 10 |  |  |  |  |  |  | 34 | 8 | 2 | 2 | 46 | 204 | 250 | 3 |
| 15 | Rewriting Theory | Elective | 10 |  | 10 |  |  |  |  |  |  | 30 | 12 | 2 | 2 | 46 | 204 | 250 | 3 |
| 16 | Pattern Recognition Applications | Elective | 10 |  | 10 |  |  |  |  |  |  | 30 | 12 | 2 | 2 | 46 | 204 | 250 | 3 |
| **Total number** |  | **60** | **30** | **30** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

* According to the individual choice of the student, elective courses may be changed due to the difference in hours and independent hours spent on the research component.

**Table of Prerequisites**

| **#** | **Course title**  | **ECTS**  | **Prerequisite**  | **Semester course**  |
| --- | --- | --- | --- | --- |
| 4 | PhD Seminar II | **5** | PhD Seminar I | **2** |
| 5 | Professor's Assistantship | **5** | Pedagogy of Higher Education | **2** |
| 6 | PhD Thesis |  | All mandatory courses | **3,4,5,6** |

**Additional Table of Study Plan**

| **№** | **Course / Module / Internship / Research Component** | **Code** | **Semester** | **Prerequisites** | **Lecturer** |
| --- | --- | --- | --- | --- | --- |
| **1** | Pedagogy of Higher Education | CS401 | 1 | N/A | Natela Doghonadze |
| **2** | Research Methodology | CS402 | 1 | N/A | Giorgi GhlontiGiorgi Baghaturia |
| **3** | PhD Seminar I | CS403 | 1 | N/A | All academic staff |
| **4** | PhD Seminar II | CS404 | 2 | PhD Seminar I | All academic staff |
| **5** | Professor's Assistantship | CS405 | 2 | Pedagogy of Higher Education | All academic staff |
| **6** | PhD Thesis | CS406 | 3,4,5,6 | All mandatory courses | All academic staff |
| **7** | Cyber Physical Systems | CS407 | 1 | N/A | Tea Todua Vakhtang Rodonaia |
| **8** | Wavelets Theory | CS408 | 1 | N/A | Giorgi Baghaturia |
| **9** | Computational Thinking for Modeling and Simulation | CS409 | 1 | N/A | Khatuna Elbakidze |
| **10** | Automated Reasoning | CS410 | 1 | N/A | Mikheil Rukhaia |
| **11** | Internet of Things (IoT) |  CS411 | 1 | N/A | Tea ToduaIrakli Rodonaia |
| **12** | Access Control Models | CS412 | 2 | N/A | Mikheil Rukhaia |
| **13** | Blockchain and Cybersecurity | CS413 | 2 | N/A | Irakli Rodonaia |
| **14** | Discrete Optimization Algorithms | CS414 | 2 | N/A | Michał Małafiejski |
| **15** | Rewriting Theory | CS415 | 2 | N/A | Khatuna Elbakidze |
| **16** | Pattern Recognition Applications | CS416 | 2 | N/A | Mariam Dedabrishvili |